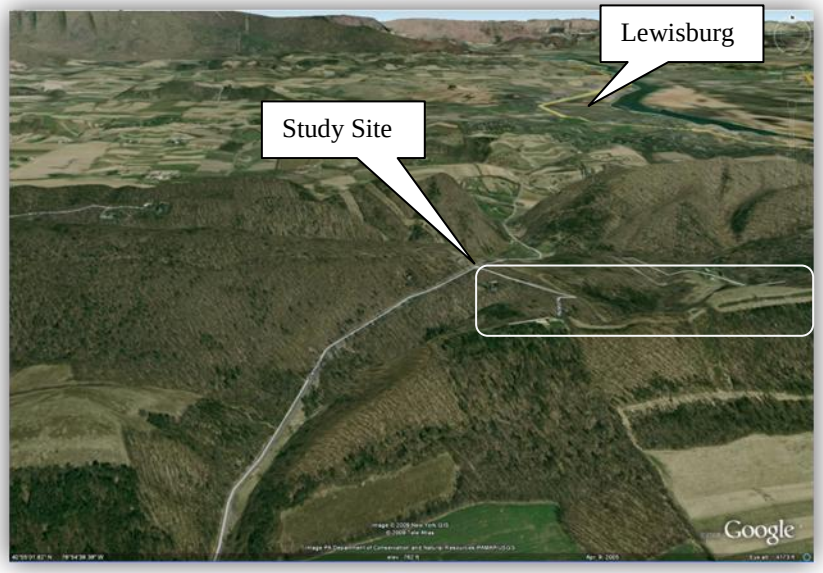
LANDSCAPE PATTERNS: A FIELD TRIP TO SHAMOKIN MOUNTAIN
BUCKNELL UNIVERSITY BIOLOGY 208

What to Bring: Appropriate footwear (e.g., hiking shoes); depending on the day, bring a warm, waterproof, or water-repellent jacket (or dress in layers); long pants, regardless – poison ivy; binoculars (if you have them); hat; sunglasses; sunscreen; water; and a notebook and pencil.

Introduction

This week we will visit Shamokin Mountain, a roughly 9-mile-long, east-west running ridge that reaches 1,100 ft above mean sea level at its highest point. The portion of Shamokin Mountain that we will visit is located four miles southwest from Bucknell University via Stein Lane. Our bus will depart from **Seventh Street adjacent to the O'Leary Center promptly at 2 pm** and we will return to campus by 5 pm.

We will do two things during our visit to Shamokin Mountain. First, we will hike the Shamokin Mountain Trail, a one-mile-plus loop trail that offers vistas of the Buffalo Valley and Dry Valley landscapes, examples of differing land management strategies, dramatic illustrations of secondary succession, and much natural history. The trail crosses several ravines that were created by water-induced erosion over millions of years. Second, we will consider conservation land management for the tract that we visit. **Your assignment is to develop a conservation management plan for the site** that includes describing how you would quantitatively sample the study site and analyze the patterns of plant species occurrences. Your plan also should offer suggestions for how to manage the land to facilitate multiple uses of the landscape, control invasive species, and encourage biodiversity. You will need to gather information during the field trip in order to develop your management plan and you must draw on what you learned from the *EcoSampler* sampling theory exercise that we completed several weeks ago in lab. **Read the following pages before our field trip so that you know what kinds of information you need to gather.**



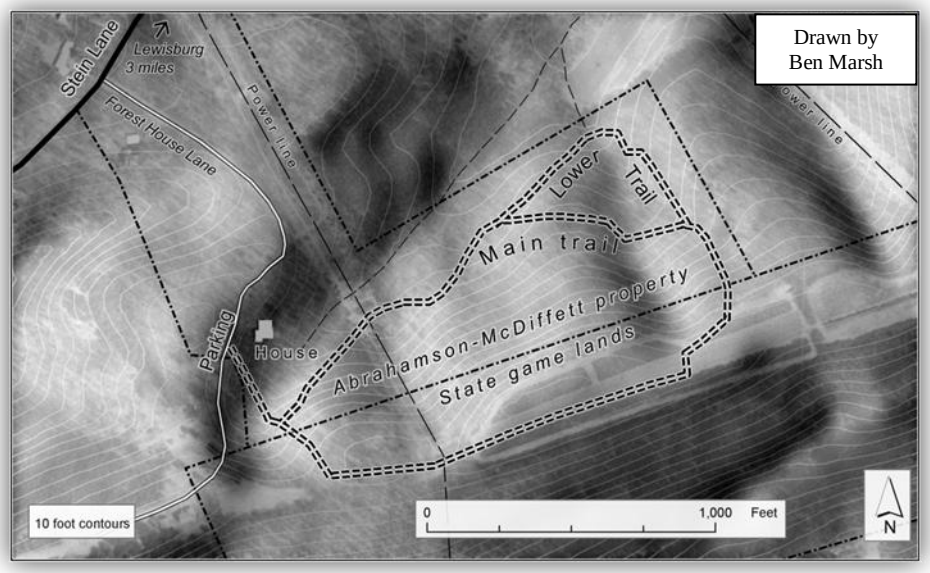
Our goals for this week's lab exercise are to:

1. Observe the characteristics of local upland communities and consider the patterns of species occurrences in relation to microclimate and edaphic (i.e., soil-related) conditions.
2. Explore the biological importance of upland forest communities from the perspectives of the refuge they offer non-migratory species and their importance on a continental scale to migratory species (consider habitat fragmentation and the role of habitat corridors).
3. Witness the tension that can exist between varied land-use practices, including farming, human habitation, transportation, hunting, and conservation on Shamokin Mountain.
4. Examine threats to the ecological integrity of upland forests.
5. See and discuss examples of concepts from our lectures, including microclimates, solar insolation and slope aspect, intraspecific competition, migration, succession, adaptation, species richness and diversity, community structure, landscape ecology, field sampling, ecological niches, and more.
6. Consider a conservation management plan for Shamokin Mountain that includes the protection of habitat for native species, control of invasive, alien species, as well as the accommodation of diverse land uses

including farming, timber production, hunting, hiking, nature education, and scientific study.

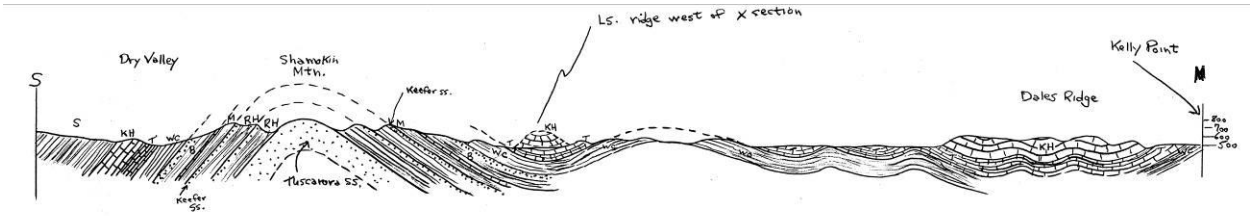
The Shamokin Mountain Trail's Story

The Shamokin Mountain Trail is open to the public and is part of a series of trails maintained by volunteers with the Merrill Linn Land and Waterways Conservancy http://www.linnconservancy.org/. Created to encourage the enjoyment of nature, the Shamokin Mountain Trail winds through private lands owned by Warren and Chris Abrahamson, and Wayne McDiffett and Ruth Burnham, and public lands that are managed by the Pennsylvania Game Commission.



Geology

The story of Shamokin Mountain begins well over 400 million years ago during the Silurian Period. During this time, large deposits of sandstone were laid down over the central Pennsylvania landscape and subsequently these deposits were buried by thick layers of shale. Approximately 300 million years ago (mya), the continental land masses of Africa and North America collided due to continental drift. This resulted in the so-called **Allegheny orogeny** that produced the topography, including the geological uplifts that we see today from the power line on the Shamokin Mountain Trail.



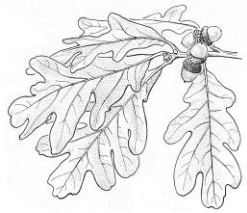
View Looking West from Lewisburg, PA
3X Vertical Exaggeration Sketch by Richard Nickelsen

0 1 2 3 miles

S = Middle Devonian Shales
KH = Keyser-Helderberg Fossiliferous Limestones
T = Tonoloway Limestone/Calcareous Shale
WC = Wills Creek Shale
B = Bloomsburg Fossiliferous Shale
M = Mifflintown Shale and Fossiliferous Limestone
RH = Rose Hill Shale
Tuscarora Sandstone

Consequently, two main deposits underlie Shamokin Mountain. The first and older deposit, the **Tuscarora sandstone**, is approximately 500 ft thick and dates to roughly 400 mya. This rock is a major ridge builder because it is among the hardest, most erosion-resistant rocks in the region. Although it is underfoot, the Tuscarora sandstone has no outcrops along the trail. Outcrops of Tuscarora sandstone can be seen north of the trail along Stein Lane.

The second, more recent deposit is the **Rose Hill shale**. This shale was originally a green color, but subsequent weathering changed the shale to its present orange-red color as the oxidation state of iron contained within the shale changed. Burrowing animals have excavated chips of this shale along the trail, especially along the steep descent from the State Game Land. If you look closely at pieces of this shale, you may find **trace fossils** of the burrows of ancient



White Oak

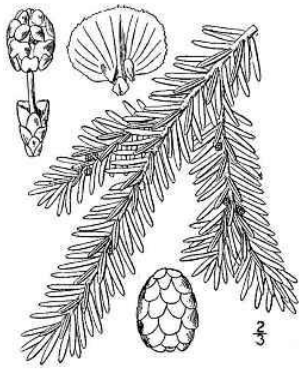
creatures that were preserved in this shale.

Shamokin Mountain's soils are **strongly acidic** (pH 4.5-5.1) and **nutrient-poor**, which limits the growth rates of plants and may impact the species richness of the site. The underlying bedrock is near the surface and consequently bedrock limits the rooting depth of shrubs and trees. The soil is generally very well drained and is prone to become droughty during rain-free periods, further limiting tree survival and growth rates. However, specific sites have restricted drainage and two flowing springs are located along the trail.

Red Maple

Vegetation

The forest vegetation along the trail is typical of what is seen today throughout the central Pennsylvania **Ridge and Valley Province**. However, today's forest is quite different from the forests that this region's Native Americans knew. Heavy logging during the 19th and early 20th centuries, and the **chestnut blight** that arrived in the early 1900s have changed the region's vegetation from an **oak-chestnut** dominated area to one dominated by a **mixed-oak** association. The Abrahamson-McDiffett-Burnham property was last logged in the mid-1950s and consequently, the vegetation along the trail is a good example of the associations that develop 60 years after a selective-logging event. While there are some trees in excess of 100 years old, most are younger. Currently, the three most dominant tree species in the forest are **chestnut oak, red oak,** and **black oak** but **white oak, scarlet oak,** and **red maple** are also common. Since the mid-1970s the alien **gypsy moth** has impacted the Shamokin Mountain forest. This generalist-feeding herbivore prefers oaks and consequently outbreaks of gypsy moth differentially impact on oak species. **Acid precipitation** adds another stress to this forest given the already strongly acidic nature of the soils and their limited buffering ability. These may be reasons why when you look closely at the forest's sub-canopy you will see that red maple is strongly invading this oak forest. Without disturbance, the domination of the forest's canopy by oaks will change as more competitive (and perhaps more tolerant) species grow. There are over 20 tree species growing along the trail. Other common deciduous trees include **pignut hickory, mockernut hickory, American beech, big-toothed aspen, sugar maple, black cherry, sweet cherry,** and **tulip tree**.



Eastern Hemlock

There are also stands within the forest that are dominated by coniferous trees. A good example is the **eastern hemlock** stand along the north-facing slope just west of the power line and south of the trail. However, look closely and you'll see that this stand is in decline because of the impacts of the **hemlock woolly adelgid**, a small Asian insect accidentally introduced to North America. It was first described in western North America in 1924 and it was identified in eastern North America near Richmond, VA in 1951. Consequently, eastern hemlock and hemlock forests are declining across our region. The fate of hemlock may be similar to that of the American chestnut, which was devastated by the **chestnut-blight fungus** that was accidentally introduced to North America between 1900 and 1908. **White pine** is present throughout the forest and is invading the forest east of the power line, where the open oak canopy facilitates its invasion. The ages of these pines tell us that they invaded primarily after the logging disturbance in the mid-1950s and that the rate of invasion has slowed in recent decades.

Asian Hemlock Woolly Adelgid

The understory vegetation varies from place-to-place along the trail. The most common understory tree is **shadbush**, along with saplings of potential canopy trees. Several shrubs are common including the evergreen **mountain laurel**, the Pennsylvania state flower. Unfortunately, the understory in several areas and under the power line has been invaded by alien's **multiflora rose, bush honeysuckle,** and **autumn olive**. Each of these species was introduced by the Pennsylvania Game Commission as cover for wildlife but these aliens, now listed as **noxious weeds,** quickly became invasive species that displace native plants.

Native understory herbaceous plants include the **mayapple,** which grows in better-lighted patches throughout the forest (such as south-facing slopes). Other common forest wildflowers include the **wood aster, crooked-stem aster,** and **blue-stemmed goldenrod**. Hiking the Shamokin Mountain Trail in spring provides an opportunity to see the beautiful **round-lobed hepatica** and **trailing arbutus** in

bloom.

In addition to land-use history, topography and geography also strongly impact on the vegetative patterns along the trail. **North-facing slopes**, for example, have populations of coniferous trees, including white pine and eastern hemlock, and deciduous trees (e.g., oaks and red maple) while the **south-facing slopes** have populations of deciduous trees (e.g., oaks and hickories) but virtually no coniferous populations.

Fauna

The Shamokin Mountain supports a number of vertebrates. **Gray squirrels** are abundant because of the availability of acorns, hickory nuts, and other forage. **White-tailed deer, red fox, raccoon, opossum,** and **striped skunk** are seen year round and during the warmer months, the **black bear, eastern box turtle, garter snake,** and **black rat snake** are observed in the area.

The beautiful **Pileated woodpecker** is often heard or seen in the area, and its elongated chisel holes mark many dead or insect-infested trees on the property. Other woodpeckers include the **hairy, downy,** and **red-bellied woodpeckers**. Other resident birds include the **black-capped chickadee, tufted titmouse,** and the **white-breasted nuthatch**. Flocks of **wild turkey** frequent the area and if you return to hike the trail on spring evenings, you could hear or see the **American woodcock**, the small **eastern screech owl** or its large cousin, the **great horned owl**.

Pileated Woodpecker

Birds that migrate from warmer regions to Pennsylvania to breed during spring and summer include the **yellow-bellied sapsucker**. Although the sapsucker is rarely seen, its horizontal rows of peck holes occur on several tulip trees near the trail. The **wood thrush**, which winters in the rainforests of Latin America, punctuates the morning and evening stillness of late spring and summer with its melodic song. Other migratory birds include the **phoebe, Carolina wren, gray catbird, ruby-throated hummingbird, yellow-billed cuckoo,** and the spectacular **scarlet tanager**.

The populations of many of the migrant birds that breed in central Pennsylvania are in danger due to the destruction of their habitat. Wood thrush populations, for example, have declined by 30% over the past decade. One of several causes of this decline is **habitat fragmentation**, which by increasing habitat edges facilitates **nest parasitism** by the **cowbird**. Forest-dwelling migratory birds are also threatened by the loss of forest **corridors** between temperate and tropical areas. **Tropical wintering habitats** are also being destroyed as forests are converted to agriculture. Conservation efforts in both North and South America will be crucial to the long-term protection of our migrant birds.

Disturbance and Succession

The Shamokin Mountain Trail offers numerous examples of human-caused and natural disturbances that result in **secondary succession**. The logging of the area in the mid 1950s initiated a strong successional response as gaps in the forest canopy enhanced light levels at the forest floor, which facilitated seed germination and sprouting by formerly suppressed species. In addition to such human disturbance, natural disturbances occur annually via ice and wind storms. Occasionally, major natural disturbance events take place that return succession to an earlier **seral stage**. On 21 July 2003, a **mesoscale convective system** (MCS) crossed Pennsylvania from west to east and severely impacted forests and human-made structures (e.g., Kinzua Bridge collapse). A MCS is a complex of thunderstorms that become organized on a scale much larger than individual thunderstorms. Their low-pressure center pulls winds into a circling pattern, or vortex. Such **mesocyclone** winds flattened a sizeable stand of forest adjacent to the trail and toppled a number of the largest, and hence canopy-emergent, trees along the trail. As a consequence, we can see numerous examples of **sere** development that range from small areas of active recruitment due to canopy gaps caused by single tree falls to large recruit areas that resulted from damage to an entire stand.

Issues and Questions Relevant to Your Assignment

The issues and questions below are for discussion during our field trip. The answers are relevant to the conservation management plan that you will prepare.

1. As you walk the trail today, take notes on the physical and biological qualities of the forest. Think about what physical and biological factors determine where specific species live. **Your mission today is to gather information that will provide the foundation of your conservation management plan.** Consequently, you should ask questions and make observations to strengthen your plan.

2. We will begin our hike at the trailhead in an area that was selectively logged about 60 years ago. Notice the mix of tree species in the canopy and the understory. After walking down slope for a short distance, we will climb a gradual northwest-facing slope to the spine of Shamokin Mountain. The understory and canopy tree species along the upslope trail differ from those near the trailhead. **What patterns can you discern for the distributions of individual species with respective to slope and aspect** (aspect is the direction that a mountain slope faces)**?**

3. We will see multiple watersheds from the spine of Shamokin Mountain – runoff from the Buffalo Valley side of Shamokin Mountain ends up in Turtle Creek, which runs to the Susquehanna south of Lewisburg while runoff from the Dry Valley side moves into Winfield Creek and runs to the Susquehanna at Winfield. **Think about how has water erosion over millions of years has shaped the landscape you are viewing and how this landscape affects the patterns of species distribution. Study the geology diagram of the Buffalo Valley on page 2 – think about what Shamokin Mountain looked like 300 million years ago versus today.**

4. We will next cross fields managed by the Pennsylvania Game Commission. Consider their management plan as well as which wildlife species are most likely to benefit from their land-management strategy. We will then descend a relatively steep trail back onto the McDiffett-Burnham-Abrahamson land, which is managed very differently. **Which management plan do you think best benefits native species and why? What factors threaten the biodiversity of this forest (consider invasive species and atmospheric inputs)?**

5. Next, we will view the area impacted by the 21 July 2003 **mesoscale convective system** storm. **What evidence do you see that suggests succession is occurring? What species are replacing the storm-impacted species?**

6. The water you see flowing from the nearby spring is fed by drainage from upslope that percolates through the fractured Rose Hill layer to the much less pervious Tuscarora sandstone layer. **How might the availability of water in springs like this one affect wildlife?**

7. You will see many alien plant species on the State Game Lands, some of which (e.g., multiflora rose and autumn olive) have invaded the adjacent forest and followed the PPL power line. **Why do think these aliens are more invasive on the power line than in the forest (consider the levels of disturbance)? How might the presence of the power line impact microclimate as well as wildlife? How should the power line habitat be managed (think about ecotones)?**

8. Finally we will hike to an east-to-west running ravine in front of Professor Abrahamson's home where you will complete your information acquisition for your conservation management plan. **Ask questions**!

Your Assignment – A Conservation Management Plan (follow these instructions carefully!)

Please review the information below and **prepare a conservation management plan** that outlines how you would determine the patterns of microclimatic differences across the site, the distributions of tree, shrub, and herb species across the site. Entitle your report "**A Conservation Plan for Shamokin Mountain**" or something similar. Your proposal should be written in **paragraph format** and must include **five sections** that are separated by the headings: **Introduction, Goals, Methods, Expected Results, and Literature Cited**. Your proposal text must not exceed **1,500 words or roughly 3 single-spaced pages**.

Imagine that you are going to submit your plan to the **Pennsylvania Game Commission and the land owners** for their review and possible execution. You should develop a management plan with sufficient supporting information to make a convincing case for your plan. You are welcome to use outside resources and if you do, be sure to include them in the **Literature Cited** section. However, your plan can be completed without referring to information other than your field notes from our Shamokin Mountain visit, the Smith and Smith (2009) and Freeman (2008) textbooks, this handout, the *EcoSampler* handout and exercise http://www.departments.bucknell.edu/biology/courses/core/biol208/labs/, the Shamokin Mountain plant list available from Dr. Abrahamson's Plant Systematics course website http://www.facstaff.bucknell.edu/abrahmsn/bi330/location/shamok.html, and the Virginia Tech Dendrology website http://www.cnr.vt.edu/dendro/dendrology/main.htm that you visited when you explored *EcoSampler*.

The five specific sections for your Conservation Management Plan include:

1. Introduction

The Introduction should **establish the context and background of your study and plan**. Think about what your readers need to know – what past and present events created the landscape that we see today? What factors affect the biodiversity of the study site and the distribution of species? What theories and concepts support the management plan that you offer? The information provided by the instructors as we hiked the trail, the Smith and Smith (2009) and Freeman (2008) textbooks, the *EcoSampler* exercise that we completed in lab, and your BIOL 208 lecture notes will be valuable – as will the questions that you ask during our hike.

For example, you will see marked variation in the distributions of plant species across the study area. Some of this variation is due factors such as microclimate, slope, soil depth, as well as disturbance. Think about the ways in which human and natural disturbances superimpose on the microclimate- and edaphic-forced successional patterns.

Goals

State several **goals for your conservation management plan**. To reach your goals, you will need specific information about the study site – what information do you need and how would you get it (you may need to do some sampling at the study site to get that information)? For example, you may want to know how microclimates, how plant species abundances, and how disturbance factors vary across the site. Emphasize the broader ecological context. For example, human and natural disturbances impact on species and community responses. Insight into these impacts may help us understand why invasive species are present in some areas and not in others. Assess current land management practices – what changes to these plans might benefit biodiversity and, landscape community dynamics, and the resilience of species to disturbance?

2. Methods

Describe **how you would gather the information you need for your conservation management plant.** For example, how would you determine patterns of microclimate and soil variation as well as the patterns of species distributions and disturbance across the study site? You are well prepared to write this section since you can apply what you learned about sampling theory while working with *EcoSampler*. For example, be specific about which technique (e.g., area or point-quarter sampling) you would employ to examine patterns of plant species distribution.

3. Expected Results and Conservation Management Plan

Revisit the Introduction that you offered and use the points that you made there as you "jump off point" here. Your plan might address how the various land uses within the study area can coexist, how to better control invasive species and protect native species, how the study site might better serve non-migratory and migratory animals. Remember that plant species differ in abundance in different portions of the study site (e.g., on different slopes, under different disturbance regimes). Your plan should help the Pennsylvania Game Commission and the land owners be better stewards of the land. The bottom line is how will your plan provide resources and habitat for native plants and animals while controlling invasive, alien species and also accommodate or even facilitate diverse land uses including farming, timber production, hunting, hiking, nature education, and scientific study?

4. Literature Cited

Include citations of the sources that you've cited in your plan such as:

Abrahamson, W.G. 1999. BIOL 330 Plant Systematics. Shamokin Mountain: Plant species list. http://www.facstaff.bucknell.edu/abrahmsn/bi330/location/shamok.html

Freeman, S. 2008. Biological Science, Volume 2 Evolution, Diversity, and Ecology, 3rd edition. Pearson Education, Inc., San Francisco, CA.

Smith, T.M. and R.L. Smith. 2009. Elements of Ecology, 7th edition. Pearson Educational, Inc., San Francisco, CA.